WINTER FOOD OF OKLAHOMA QUAIL*

BY LOIS GOULD BIRD AND R. D. BIRD

This study is based upon an examination of the crops of 138 quail taken in nineteen counties of Oklahoma. Of these, 135 were taken in December, 1929, during the latter part of the quail season and were sent to us by the state game rangers in response to a request made to Mr. Marsh B. Woodruff, then Assistant Game Warden. Three crops were taken in November by R. D. Bird. With the exception of four crops from Arizona Scaled Quail (*Callipepla squamata pallida*) from Cimmarron County, they were all from Bob-white (*Colinus virginianus virginianus*).

The study of the winter food of birds is important because winter is the critical time of food gathering. It is then that food is scarcest.

Food taken from bird crops is easily studied, for the contents have not been subjected to the process of digestion and are not affected by chemical action. The crop is a membranous, sac-like region of the oesophagus, easily distensible, which is used for the reception of food. Its capacity is from four to six times that of the gizzard. (2, p. 28). Seeds and insects in the crop, although in some cases broken and dirty, are in practically the same condition as when lying on the ground.

Previous Work

Dr. Sylvester D. Judd, of the United States Biological Survey, who has made extensive studies of the food of the Bob-white, states: "The Bob-white is probably the most useful abundant species on the farm. It is one of the most nearly omnivorous birds, consuming large quantities of weed seeds, and destroying many of the worst insect pests with which the farmer has to contend. It does not injure grain, fruit, or any other crop." (1, p. 194).

The food habits of the Bob-white have been studied by the Biological Survey both in the laboratory and in the field. On the basis of 918 stomachs from twenty-one states, Canada, the District of Columbia, and Mexico, collected in every month of the year, the food, calculated by volume, was: seeds, chiefly weeds, 52.83 per cent; grain 17.38 per cent; fruit 9.57 per cent; miscellaneous vegetable matter 3.81 per cent; animal matter, mainly insects, 16.41 per cent. (2, p. 27).

The character of the food varies with the season. It is chiefly vegetable matter from October to March and largely insects during the late spring and summer. (2, p. 28).

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Leguminous seeds form 15.52 per cent of the yearly food. Of this all but a small fraction comes from wild plants which are classed as weeds. In December legume seeds are eaten to the largest extent, when they form 25 per cent of the food. (2, p. 28).

The Bob-white is a notable exception to the fact that grain-eating birds are likely to do much harm to crops. The grain taken by Bob-whites is gleaned from stubble fields after harvest. This gleaning of waste grain is a beneficial habit, for volunteer grain is undesirable, especially where insect pests or parasitic fungi are to be combated. (2, pp. 29-30).

Among the insects eaten by the Bob-white are included many pests, some of which are the potato beetle, twelve-spotted cucumber beetle, striped cucumber beetle, various cutworms, army worm, cotton bollworm, cotton boll weevil, may beetle, red-legged grasshopper, Rocky Mountain locust, and chinch bug. The foraging habits of the Bob-white which extend to the center of the cultivated fields are of much benefit to the farmer. (2).

The amount and variety of food eaten by the Bob-white has been studied by Mrs. Nice (4), who says that "the Bob-white is known to eat 129 different kinds of weed seeds". "They eat 15 grams, or half an ounce, of weed seed daily throughout the winter" "and from 12 to 24 grams of insects daily in the summer". An estimate of the average amount eaten by a single Bob-white in a year is about five pounds of insects and nine and three-quarters pounds of weed seeds, equivalent to over sixty-five thousand insects and more than five million weed seeds. (4, p. 312).

Recent studies have been made of the food of quail by Stoddard (7) and Tate (8). In the study of 120 Bob-white stomachs taken in Georgia in December, 1924, Mr. Stoddard reports that pine mast made up 41 per cent of the food by bulk, legume seeds 31 per cent, sweet gum 4 per cent, ragweed 3 per cent, corn 3.5 per cent, and grasshoppers 5 per cent. (6, p. 16).

Mr. Tate, observing in the Panhandle of Oklahoma, reports as the favorite foods of the two quail within the state:

Bob-white: Grasshoppers, flies, crickets, aphids, burdock, pigweed, lamb's quarter, and Russian thistle seeds, milo maize, kaffir, and millet.

Arizona Scaled Quail: Grasshoppers, flies, ants, beetles, sunflower seeds, Russian thistle and lamb's quarter seed, milo maize, and kaffir.

Mr. Tate's observations were made as a result of examination of crop contents, field observations and feeding table records. (8, p. 33).

Ortenburger and Little (6) give the stomach contents of two Bob-whites from Harmon County and one Arizona Sealed Quail from Cimarron County.

As far as we now know, no other studies have been made of the food of Oklahoma quail.

Distribution of Crops

The crops were well distributed over the state. (See map, fig. 54). The counties represented were:

Panhandle: Cimarron, Texas, Beaver.

Northwest: Harper.

Southwest: Beekham, Jackson, Comanehe.

Fig. 54. A map of Oklahoma showing counties and distribution of crops. The numbers refer to the numbers of crops taken. They were all of Bob-white, except the four so marked in Cimarron County of Arizona Scaled Quail.

Central: Noble, Oklahoma, Cleveland.

Northeast: Osage, Washington, Nowata, Rogers, Craig.

Southeast: Choetaw, Pittsburg, Latimer, LeFlore.

This was a suffieiently uniform distribution, represented by an ample number of erops, to give a good representation of the food of the quail throughout the state during Deeember.

Procedure

The crops were taken from the birds, wrapped in paper and sent to us. They were opened, sorted and the eontents plaeed in glass vials or gelatin capsules. The eapsules proved most satisfaetory for keeping separate small quantities of seeds, sinee they eould be written upon and were transparent and inexpensive.

After the seeds were sorted, samples of undetermined species were sent to Mr. W. L. McAtee, of the United States Biologieal Survey, for

identification. From these identified samples, the others were named.

Insect identifications were made by R. D. Bird. Because of the fragmentary and broken condition, some of these could be placed only to the order. Others in better condition could be placed to the species.

Identification completed, the percentages of different kinds of seeds in each crop were estimated. Following the advice of Mr. McAtee, the percentage by bulk method was used rather than the numerical method. (3) The crop percentages were combined into county averages and from these the state average was computed. These averages are shown in the accompanying table (Table I) and graph (fig. 55).

Discussion

Food of the Bob-white

The examination showed that the proportions of the total state food of the Bob-white was:

Weed seeds*	50.8 per cent
Grain	35.1 per cent
Tree and shrub seeds	11.9 per cent
Insects and snails	1.5 per cent
Miscellaneous vegetable matter	.7 per cent

Plant Food

Vegetable matter made up 98.5 per cent of the food. Half of this consisted of weed seeds, chiefly from common and bothersome weeds, such as ragweed, sunflower, smartweed, pigweed, beggar-ticks, tick trefoil, and thistle. A total of fifty-three different kinds of wild seeds were eaten.

The dry character of the food is noticeable. December is a time of dry seeds and fruits. No fresh juicy berries are present to vary the diet and the only greens eaten were leaves. Small brown galls, which resembled seeds, were found three times. Tiny pebbles were occasionally taken, probably as grit for the gizzard.

Amount of Food Eaten

The volume of the contents varied from crops filled to almost bursting to some which were almost and one which was entirely empty.

One crop contained 905 ragweed seeds and another 722. Other examples of large numbers of seeds in crops were 1902 bush clover seeds, 88 trailing wild beans, 722 sunflower seeds.

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*The word *seeds* has been used throughout to include the dry seeds and fruits eaten by the quail.

Weed Seeds

Ragweed* seeds were abundantly eaten by quail all over the state. They were found in eighty-one crops from sixteen counties. On the graph (fig. 55) ragweed shows the most even average and distribution

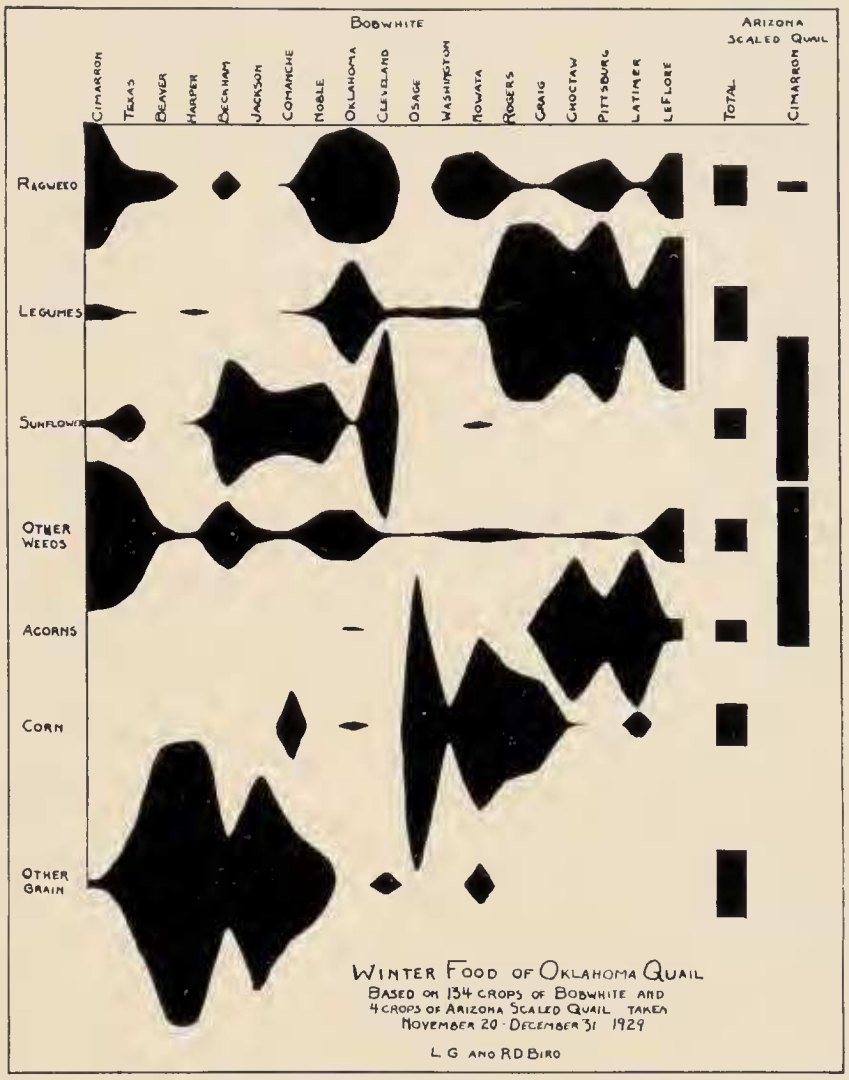

Fig. 55. A graphical representation of the percentages in bulk of the most important items of the winter food of quail in Oklahoma. The counties read from west to east across the state. The total column represents the average percentage of each throughout the state.

of all foods. No high peaks appear and in no county did it form more than 40 per cent of the food eaten. The destruction of this amount of ragweed seed is most beneficial, for this is a disagreeable and noxious roadside weed. It is hated by farmers and feared by everyone who is a victim of hay fever.

*Two kinds of ragweed seeds were found in the crops: a large type, *Ambrosia trifida*, the great ragweed, and a small type, which has been referred to in the table as *A. artemisiifolia*, the common ragweed. It is possible that some of this latter kind may belong to some of the other small ragweeds found in the state, but the greater part are probably *A. artemisiifolia*.

Sunflower seeds (*Helianthus* sp.) formed 9.8 per cent of the total diet. These were eaten mainly by the Bob-white of the western and central part of the state. Three from Cleveland County had 58.3 per cent of their crops filled with them. In the southwestern counties, Beckham, Jackson, and Comanche, sunflower seeds composed from 20 to 40 per cent of the food.

Legume seeds were eaten largely by quail in the eastern counties, although some were found in crops from all but Beaver, Beckham, and Jackson Counties. The state average was 17.3 per cent. Pittsburg County (56.8 per cent), Craig (56 per cent), and Rogers (55.3 per cent) led with the largest proportions.

The seeds of the trailing wild bean (*Strophostyles helvola*), a prostrate annual of sandy places, were eaten in the largest percentages. This seed is large, dark, and of an oblong shape with truncate ends. Its dark color would make it show up easily against the light-colored sand.

Two species of bush clover (*Lespedeza* spp.), one with seeds of dark brown (this was the most common) and the other with green seeds, formed nearly 5 per cent of the total food. These were eaten mainly in the southeastern counties. *Lespedeza* is a well known legume advocated as a range food for livestock. It is interesting, therefore, to note its importance as a quail food.

The downy milk pea (*Galactia volubilis*) also was an important leguminous food. Partridge pea (*Cassia chamaecrista*) and tick trefoil (*Desmodium* sp.), were eaten in smaller quantities.

The thistle (*Cirsium* sp.) formed less than 2 per cent of the total and was eaten largely in the Panhandle.

Snow-on-the-mountain (*Euphorbia marginata*), a conspicuous green and white herb, with large seeds, was eaten to some extent, mainly in Noble County and in the northwest. Other spurges (*Euphorbia* sp. and *Croton* sp.) appeared in small quantities in crops from scattered parts of the state.

The yellow seeds of the ground cherry (*Physalis* sp.) were eaten in Beckham, Jackson, and Noble Counties.

The tiny black shining seeds of pigweed (*Amaranthus retroflexus*) attracted the sharp eyes of the Bob-white in various parts of the state but were not eaten to a large extent.

Beggar-ticks (*Bidens* sp.) were eaten in the central and eastern part of the state and formed 1.2 per cent of the state total.

Indications of the work of the Bob-white in the grain fields appeared in the counts of some Comanche County crops. One of these

had 90 per cent kaffir corn and 10 per cent crab grass (*Digitaria sanguinalis*). Other crops showed combinations of sunflower or ragweed with corn, or sunflower with wheat, with a sprinkling of crab grass. It is evident that these Bob-whites when killed were feeding in weed grown stubble fields, gleaning the fallen grain and eating the seeds of bothersome weeds.

Panic grass (*Panicum* sp.) was found in a number of the crops, but the smallness of the individual seeds kept it from being of more importance.

Other seeds eaten by the Bob-white in quantities too small to be of importance were:

Acalypha sp.
Andropogon furcatus
Arenaria sp.
Aster sp.
Callirhoe sp.
Carex sp.
Cenchrus pauciflorus
Chenopodium album
Commelina sp.
Crotonopsis linearis
Croton sp.
Diodia teres
Euphorbia dentata
Euphorbia sp.
Geranium carolinianum
Hosackia sp.
Iva sp.
Paspalum sp.
Polygala sp.
Psedera sp.
Rhynchosia sp.
Rhynchospora sp.
Rumex (altissimus?)
Scleria sp.
Sesbania macrocarpa
Setaria glauca
Solanum rostratum
Stillingia sp.
Stillingia sylvatica
Stipa sp.

Grain

Corn picked up as waste grain from the winter fields formed a large part of the quail diet in the northeastern counties. It is to be noted that this corn was taken in a corn growing district where kaffir and milo maize were not grown to a large extent.

Kaffir corn and milo maize were eaten in the western part of the state.

Wheat, in the region of winter wheat, formed but 1 per cent of the total and was eaten in only three counties, Noble, Comanche, and Texas. Barley formed 20 per cent of the food in Beckham County (this was on the basis of one crop, the only one sent in from this locality).

Red-top cane, Johnson grass, and Sudan grass were taken in Comanche County and to a much smaller degree in Cimarron.

Tree and Shrub Seeds

Fragments of acorns (*Quercus* sp.) were eaten in large numbers by the Bob-white in the southeast. Fifty per cent of the diet of those

Species	BOB-WHITE																				ARIZONA SCALED QUAIL
	Cimarron	Texas	Beaver	Harper	Beckham	Jackson	Comanche	Noble	Oklahoma	Cleveland	Osage	Washington	Nowata	Rogers	Craig	Choctaw	Pittsburg	Latimer	LeFlore	Total	Cimarron
Crops Examined	2	4	2	2	1	4	22	9	15	3	2	4	7*	6*	2	17	5	3	24	134	4
WEED SEEDS																					
Pigweed (Amaranthus retroflexus)	.1				1.0	.6	.1						.7							.1	.3
Common Ragweed (Ambrosia artemisiifolia)	35.0	5.8	7.5		9.0		1.7	31.1	36.6	21.3		17.3	21.7	5.5		6.0	17.0	1.0	19.3	12.4	
Giant Ragweed (Ambrosia trifida)	5.0	4.7								5.5			.3		.5	5.0		.7	.8	1.2	3.0
Beggar-ticks (Bidens sp.)									14.7			1.8	2.7						5.3	1.3	
Thistle (Cirsium sp.)	33.5	19.5	2.5		1.0			.1	.1											3.0	
Snow-on-the-mountain (Euphorbia marginata)	2.5	.5		2.0				6.0												.6	
Sunflower (Helianthus sp.)	3.0	12.5		1.0	40.0	23.8	20.2	26.3	.1	58.3			1.6							9.8	45.2
Panic Grass (Panicum sp.)	.4						.1	.1	.1	.5			.1	.8	1.0	.2	1.0		4.0	.4	.3
Ground Cherry (Physalis sp.)					20.0	4.3		1.5												1.4	
Knotweed (Polygonum sp.)	1.5	10.5	1.0				.1	1.4						.1				.7		.8	
Russian Thistle (Salsola Kali Var. tenuifolia)																					47.5
Crab Grass (Digitaria sanguinalis)							.9			.7		.5		.3			.4		4.3	.4	
Other Seeds	9.3	5.5	1.5				2.0	6.2	2.2	.6	1.0	.7	.7	2.8		1.8	2.3		3.5	2.1	1.8
LEGUME SEEDS																					
Partridge Pea (Cassia Chamaecrista)								.1	2.8	.7						.1	.8	.3	.5	.3	
Downy Milk Pea (Galactia volubilis)	5.0						.5	1.7	8.0		3.0	.8	2.3	48.0		1.6	.8		.5	3.8	
Bush Clover (Lespedeza sp.)									.5			2.5	.2	.1		16.7	31.2	2.7	38.7	4.9	
Tick Trefoil (Desmodium sp.)									6.3			.7		.2		18.6	2.0		1.0	1.5	
Psoralea (Psoralea sp.)		.5		2.0			.1	1.4												.2	
Locust (Robinia Pseudo-acacia)								3.4												.2	
Trailing Wild Bean (Strophostyles helvola)									15.0	1.7			.3	7.0	56.0	.4	22.0	11.7	7.3	6.4	
TREE AND SHRUB SEEDS																					
Chittimwood (Bumelia lanuginosa)							13.3													.7	
Sweet Gum (Liquidambar styraciflua)																			3.3	.2	
Acorn (Quercus sp.)									.2					16.0	45.2	20.8	50.0		7.1	7.3	
Sumac (Rhus glabra)						1.3	1.4		2.1			64.0							2.2	3.7	

TABLE I. A tabulation by counties of the percentages in bulk of all items observed in the crops examined. The counties read from west to east across the state. The total column gives the average percentages for the state.

GRAIN																							
Corn							22.0		3.6		93.5	11.7	55.7	34.7	26.5	.9		8.3		13.5			
Kaffir Corn		33.5	87.0		9.0	68.0	14.4			6.0										11.5			
Milo Maize				90.0						1.0			13.4					23.3		6.7			
Wheat		.3					1.5	19.3												1.1			
Other Grain	2.5	.5			20.0		20.9													2.3			
PLANT MATERIAL, ETC.																							
Galls									1.7							.5		.3		.1			
Leaf Fragments		1.0		1.0	.2		.1	.5	2.3							.6	1.3		1.1	.4		.2	
Stones. Rubbish. Etc.			.5								1.5					.9				.1			
ANIMAL MATTER																							
Insects	2.0	5.2		4.0		2.0	.6	.9	2.0	4.7	1.0		.3	.5		.8	.4	.7	.4	1.4		1.6	
Snails							.1		.7							.7		.3	.7	.1		.1	

*Three of the six crops included in the Rogers County column were taken in Nowata County. The six were wrapped together and could not be separated.

taken in Latimer County consisted of these. The total was 7.3 per cent. Some of the acorns had been swallowed whole, a tribute to the stretching capacity of the Bob-white's gullet, but most were in fragments and had probably been pecked to pieces before being eaten.

The red berries of the sumac (*Rhus glabra*), of wide distribution in the state, formed 3.7 per cent of the quail's food. This was greatest in Washington County, an erratic record, for sumac berries were not found in any of the crops from the adjoining counties. Of three of the four crops taken in Washington County, each showed over 80 per cent sumac. This shrub grows along the forest edge, a habitat frequented by the Bob-white.

The shiny, large brown seeds of the chittimwood berries (*Bumelia lanuginosa*) had been eaten by the quail of Comanche County. The blue-black berries may have dried and lost their envelope of goodness before the birds found them, for only the hard seeds were found in the crops. Since these had been subjected to no digestive process, the outer coats were probably not present when eaten by the quail. Because of the large size of these seeds, a comparative few would form a large percentage of the food. Some forty-three were eaten by three of the twenty-two quail taken in Comanche County. These accounted for the .7 per cent of the state total and 13.3 per cent of the county average.

The winged seeds from the rough burrs of the sweet gum trees (*Liquidambar styraciflua*) of LeFlore County were eaten there, also the seeds of the sassafras (*Sassafras sassafras*).

Animal Food

Insects, at a season when the insect population was low, formed a small part of the quail diet. Part of the forms eaten were pupae and larvae. Most of the insects eaten hibernate on or near the surface of the ground and hence are easily found by the ground-feeding quail. Insects and spiders eaten were:

Arachnida: Spider (1).
Orthoptera: Mole Cricket, *Gryllotalpa* sp.(?) (fragments); Grasshopper, *Melanoplus* sp. (4).
Isoptera: Termite (1).
Homoptera: Leafhopper, *Cicadellidae* (7); Leafhopper, *Oncometopia lateralis* (4).
Hemiptera: Bug, Lygaeidae (1); Tarnished Plant Bug, *Lygus pratensis* (?) (1); Assassin Bug, Reduviidae (1).
Lepidoptera: Small Moth Larvae (1); Noctuidae (?) pupae (5).
Diptera: Cyclorraphus pupa.

Coleoptera: Flea Beetle (4); 12-spotted Cucumber Beetle, *Diabrotica 12-punctata* (1); Carabidae (3); Staphylinidae (1); Weevil (1).
Hymenoptera: Ichneumon wasp (1); Chalcid Wasp (1); Ant, *Lasius interjectus* (?) (2); Ant, *Camponotus caryae* (2).

Grasshopper eggs (*Melanoplus* sp. and Oedipodinae, allied to *Mestobregma*) were found in one of the crops taken in Cimarron County. Mr. Norman Criddle, who identified the eggs, suggests that the quail probably secured the eggs while dusting in the old mound of a burrowing animal, as certain grasshoppers use such places as egg beds.

Several injurious insects which occur as common pests in cultivated fields were included among those found in the crops. Notable species were grasshoppers of the genus *Melanoplus*, which are very destructive to all grain crops and pastures, and leafhoppers which suck the juices of many plants. The tarnished plant bug is a general feeder on the juices of plants and at times does a great deal of damage. A close relative of the chinch bug (family *Lygaeidae*) was found. Quail undoubtedly eat a number of hibernating chinch bugs. Pupae of the moth family, Noctuidae, were found. In this family are many injurious cutworms. Among the beetles a notably destructive species was *Diabrotica 12-punctata*, which is known in the adult stage as the 12-spotted cucumber beetle, on account of its fondness for these plants, and as the southern corn rootworm in the larval stage. Other injurious beetles were flea beetles and a weevil. Most of the other insects were of neutral importance, except the ichneumon wasp, which parasitizes injurious insects.

Small snails of two genera, *Succinea* and *Pupoides* (?), had been eaten by the Bob-white of six counties in widely scattered parts of the state. Quail evidently eat snails whenever they get a chance, but there are so few in December that they do not form an important part of the diet. The *Succinea* were eaten in the largest numbers.

Food of the Arizona Scaled Quail

The Arizona Scaled Quail is resident in the state in Cimarron County. (5). Two of the four crops sent in were from the eastern part of the county and two were from Black Mesa in the extreme northwest. Seeds of Russian thistle and sunflower comprised the greater part of the food. Other seeds eaten were pigweed, giant ragweed, panic grass, lamb's quarter, and leaves.

Insect remains consisted of one lepidopterous larva and a bug, Miridae. Grasshopper eggs (*Melanoplus bivittatus* or *M. differentialis*) were found in one of the crops.

Included among the Russian thistle seeds was a tiny snail, *Vallonia* (?) sp., which in color, size and appearance resembled the seeds. It is a question whether the quail was fooled by the snail or the snail by the quail, but the quail won out in the end.

Summary

On the basis of the contents of 138 crops (135 taken in December and 3 in November, 1929) from quail in nineteen counties well distributed over the state of Oklahoma, the following conclusions were reached:

1. Of the total food eaten by Bob-white all over the state, weed seeds composed 50.8 per cent; grain 35.1 per cent; tree and shrub seeds 11.9 per cent; animal matter 1.5 per cent; and the remainder .7 per cent.
2. The food of the Arizona Scaled Quail in Cimarron County consisted of weed seeds 98.1 per cent; animal matter 1.7 per cent; leaves .2 per cent.
3. Insects and snails form a low percentage of the food eaten in December.
4. The high percentage of grain consists of waste grain picked up from winter stubble fields.
5. Winter food of the Bob-white in the following sections of Oklahoma consists largely
   A. In the Panhandle of kaffir corn, sunflower seeds, ragweed, Russian thistle, and thistle seeds.
   B. In the southwest of corn, kaffir corn, other grain, chittimwood seeds, sunflower and ground cherry seeds.
   C. In the central part of ragweed, sunflower, legumes (especially the trailing wild bean), and wheat.
   D. In the northeast of corn, legumes, sumac, and ragweed.
   E. In the southeast of legumes, acorns, and ragweed.
6. Our results, in comparison with those of the U. S. Biological Survey, show a higher percentage of grain and of seeds, chiefly weed seeds. There is a much lower percentage of fruit and animal life. These differences are explained mainly by the fact that the Biological Survey average was based upon crops collected during all the months of the year, while ours were taken during early winter.

Acknowledgments

Our thanks are due to Mr. Marsh B. Woodruff, Assistant State Game Warden, and Mr. Van Montgomery, State Game Warden, through whom the crops were obtained. Mr .Woodruff sent letters to the state game rangers requesting that the crops be obtained and sent to us. Rangers who responded were Claude Beeson, Guymon (19 crops); A. D. Self, Boswell (17 crops); Salmon Woffard, Poteau (24 crops); Thad Wilkes, McAlester (8 crops); W. A. Ricker, Perry (9 crops); Everet W. Evans, Collinsville (21 crops); and L. E. Crawford, Lawton (22 crops). Mr. Harry Young collected fifteen crops from Oklahoma County and turned them over to the Oklahoma city ranger who sent them on to us. Our appreciation is due all of these who helped in the collection of the material.

Mr. W. L. McAtee, of the United States Biological Survey, helped with advice and had identified for us by Mr. A. C. Martin some eighty-five samples of seeds. Mr. Carl Horn, of Oklahoma City, identified seven samples also. Mr. Norman Criddle, of Treesbank, Manitoba, identified the grasshopper eggs, and Mr. Alan Mozley, of the University of North Carolina, the snails. All of these persons we wish to thank; also Mrs. M. M. Nice who kindly lent reprints otherwise unavailable to us.

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